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THE BASIN OF LAKE TITICACA.

BY

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In the heart of the western part of South America, between the 16th and 17th degrees of south latitude and the 68th and 70th of longitude west of Greenwich, lies the extensive water-sheet of Lake Titicaca, at an altitude of 12,466 feet above the level of the Pacific. By air-line it is about 300 miles from the western, and at least 2,000 miles from the Atlantic, shore. Peru claims two-thirds of its surface, and Bolivia the southeastern third; but, as yet, the boundary-line is rather indefinite.

Approach to the lake from the west and southwest is quite abrupt as far as Arequipa, where the peaks of the slumbering volcano Misti (19,250 feet), and its northern companion Charchani (20,300), rise like towering monuments. They are, for some distance, the most southerly pillars (Pichu-Pichu, about 18,000 feet high, forming but an elongated crest) of the Peruvian coast Cordillera. North of Arequipa a number of summits, part of which are mentioned in dim Indian tradition as formerly active volcanoes, rise to still greater elevations, like the Koro-Puna, the altitude of which is said to exceed 23,000 feet, which would make it the highest mountain on the American continent, so far as known. Crossing, between Misti and Charchani, a wild labyrinth of volcanic débris, a high table-land is reached, on which the railroad has to climb to 14,660 feet at the station of Cruces, near Vincocaya. This plateau is cold, bleak, and correspondingly dismal. The vicuña still roams over it in small flocks, and human abodes are few and far between. From near the culminating point the column of smoke issuing from the crater of the volcano of Ubinas rises on the southern horizon,

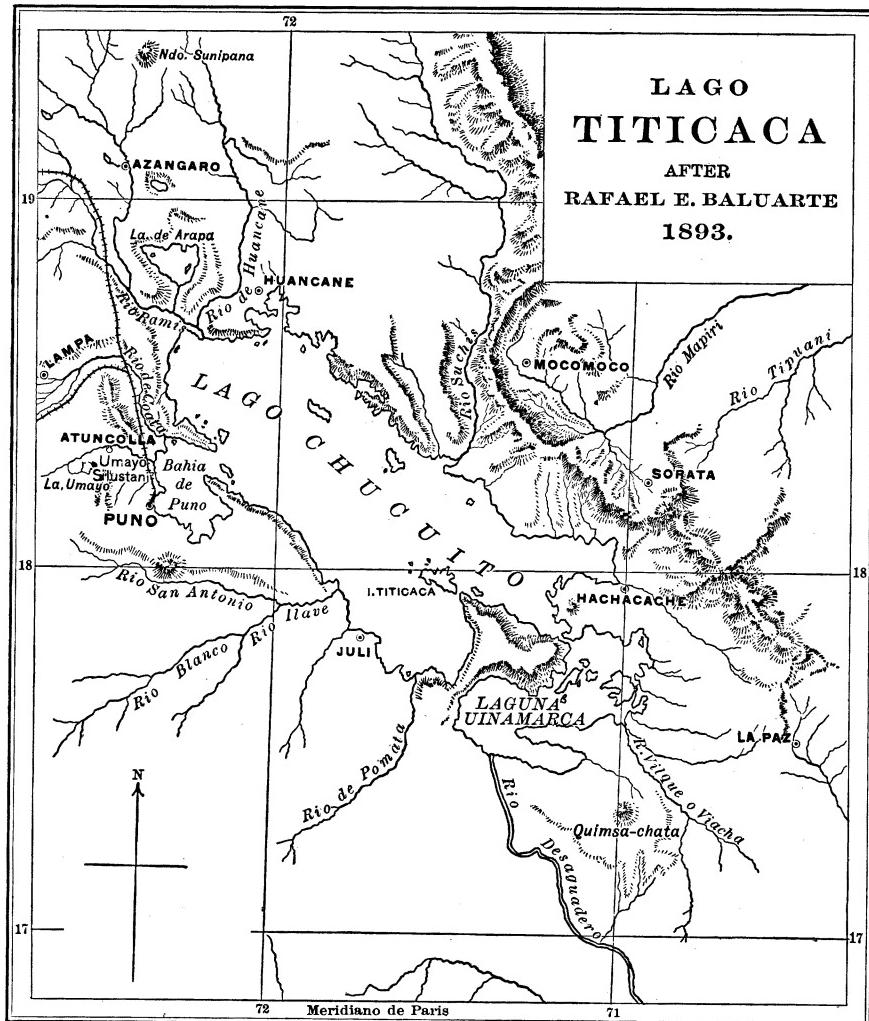
and the dark mass of Omate, the top of which was blown to atoms during the terrible eruption of 1600 (like that of Coseguina in Central America, and Mont Pelé in Martinique), rises up in the neighbourhood of Ubinas with its four prongs, indicating the ruins of its crater.

Descent to Lake Titicaca is gradual. The beautiful lagoons of Saracocha and Parinacocha, picturesque, but with very bleak shores, nestle at the base of the snow-clad range of Lampa; then a deep furrow is entered that has some arborescent vegetation, and a number of Indian settlements, haciendas, and the mining establishment of Maravillas. This furrow leads to the marshy shores of the Rio Ramis at Juliaca, a village, the site of which was occupied by an Indian settlement at the time of the Conquest. The region now reached belonged to what in primitive times was termed the Collao, and held by Indians of Aymará stock. Since then the Quichua have, under Spanish rule, slowly encroached, and they occupy the territory as far as the northern half of the town of Puno.

Lake Titicaca is reached by the railroad near the former principal settlements of the Aymará, Paucar-Colla, and Hatun-Colla, now reduced to insignificant hamlets. Neither were they ever very populous. The idea of a former large population belongs to romance. Statistics prove that the present Indian population of these regions has not diminished; and the evidence adduced in favour of a supposed dense primitive settlement of the land, based upon the countless artificial terraces that streak nearly every slope, is by no means conclusive. The extent of levels is small, and, where they lie along streams and are therefore susceptible of irrigation, they are also exposed to overflow; and a large portion of them is occupied by marshes, which, along the Ramis, are often alkaline. For this reason the Indian had to cultivate the slopes in preference, converting them into narrow terraced garden-beds. This system obtains to-day, and many of the andenes (as the Quichuas call them) are *modern*. Furthermore, the Indian had no fertilizers; neither will he use manure to-day, but prefers to let the soil restore its productiveness through rest. That rest lasts, according to local conditions, from one to ten and more years, so that only a limited extent of the numberless artificial terraces was tilled at the same time, and these are, consequently, no criterion as to former numbers of the people.

Already from the heights overlooking the track along the lake-shore a glimpse is obtained of the magnificent chain of snowy

peaks extending along the eastern side of Lake Titicaca from southeastern Peru into central Bolivia, and known, in its Bolivian portion, as the Andes of Bolivia, or Cordillera Real. Along the base of these magnificent Alps of South America, conspicuous through the strong individualization of each mountain and the



NOTE.—*Chucuito* is an older name of Lake Titicaca.

abundance of characteristic glaciers, Lake Titicaca extends from northwest to southeast like a trough, abrupt and very deep along the northeastern, and gently sloping from the western, shore, as far as the main body of the lake extends.

Puno existed, as an Indian village, certainly in 1548; hence, it is likely that the site was occupied already before the Conquest. It now has about 5,500 inhabitants, the majority of whom are mixed with Indian blood. The Spanish settlement was officially recognized as such in 1668 or 1669. It is the Peruvian port for the navigation of the lake to the Bolivian shores.

Lake Titicaca fills a trough about 120 miles long, at the southwestern base of the Bolivian Andes. It consists of the main lake, 41 miles wide at its greatest expansion, and several large bays, like the lagoon of Chucuito, on which Puno is located, the most northern bay in front of Taraco and Vilque on Peruvian territory, and the extreme southeastern lagoons of Chililaya and Uinamarca.. While in the main lake accurate determinations of depths on the west give no figures much in excess of 609 feet, on the eastern or Bolivian side we find 828 and 841 feet. Near the little island of Koa 1,312 feet are recorded. It is certain that about the Island of Titicaca, the promontory of Copacavana, and as far as the mouth of the straits of Tiquina, the lake is very deep; but in these straits, by which the main lake communicates with its southeastern annexes, depths diminish almost suddenly to 230 feet. It looks, therefore, as if Lake Titicaca had been imperceptibly falling during a period of unknown length. The lagoon of Umayo (near which stand the Inca buildings of Sillustani) was formerly connected, if tradition is right, with the lake; now the water has receded from the channels that established connection.

The only outflow of Lake Titicaca is the Desaguadero, a channel of sluggish waters draining into the lagoon of Poopó, in the southwest, which, in turn, has no visible outlet. There is traditional indication to the effect that the Desaguadero was opened (through some unknown process) at a very remote period, still within the scope of dim memory. It is also possible that, not many centuries previous to the Columbian Era, the lagoon of Uinamarca bathed a part of what are now the ruins of Tiahuanaco.

The water of Lake Titicaca is brackish, but not unwholesome. We had to drink it for several weeks almost exclusively, on the island of Koati, and felt no bad effects. It is always cold. At a depth of 99 feet Agassiz found its temperature to be  $15^{\circ}$  centigrade, at 450 feet  $10^{\circ}.6$ . Nobody has, as yet, been able to withstand its numbing effects longer than about a quarter of an hour.

There is, as indicated, a single outlet to the lake, the Desaguadero, and the feeders are few, on the surface. The Ramis and Suchez enter from the north, from the east the Rio de Achacache.

None of these rivers is more than an ordinary stream, not large enough for navigation.

During winter the sky is mostly of an intense blue, the air chilling, while the sun's rays scorch and burn face and hands. Still, thunderstorms occur every month, and snowfalls are not uncommon. In summer a lowering sky often covers the mountain ranges, which are the only redeeming feature of the landscape; thunderstorms are of almost daily occurrence, thunderbolts very frequent, and waterspouts not rare. We saw two together, in the middle of the lake, and reliable informers state that as many as five have been observed at the same time. During tempestuous nights St. Elmo fires gleam on the steamers' masts. And, yet, rare is the evening when, for a few hours at least, the Bolivian Cordillera does not shine out, even if thin vapour rises before it from the deep gorges at its foot, and seldom is the whole chain, from the Carabaya range, in the north, to Illimani, in the extreme south, completely shrouded. In August, when winter is at its height and the skies cloudless, the Bolivian Andes sometimes display an alpine glow of unequalled splendour.

Our observations of temperature on Titicaca Island, carried on for three and a half months in succession, and later ones on the same island and on its neighbour, Koati, indicate a very equable climate. The mean for January, 1895, was  $54.9^{\circ}$ ; for February,  $55.2^{\circ}$ ; in March,  $54.8^{\circ}$ . In winter of the same year temperatures were, of course, lower, but the extremes of temperature from January first to July first, 1895, were only  $65^{\circ}$  and  $33^{\circ}$ . I do not lose sight of the fact that such local observations, carried on for a short period only, have no value except for their time and the place where they were taken; but meteorological observations at La Paz extend over a period of many years, and establish the equableness of the climate beyond any doubt. That climate has, in fact, but two seasons—winter, which is cold and less moist, and summer, which is wet and equally cold. One is as disagreeable as the other, though not unhealthy.

To the coldness of the climate (first of all a consequence of the great altitude) the proximity of the snowy ranges contributes. In the west the few summits that rise above the snow-line between Puno and Moquegua, the Kaualluni, and the Uilcaconga, are neither high nor striking in appearance. The lofty ranges between Cuzco and Juliaca, towering Kunnu-Rona (Santa Rosa), and bold Vilcata, that rises above the source of the Amazon River, at La Raya, are too distant. But the eastern range approaches the lake as near

as twenty-five miles in its two culminating peaks of the Sorata group, the Hilampi, or Hanko-Kunnu, and the Hanko-Uma, rising respectively to 21,300 and 21,490 feet, according to latest determinations. The Sorata group terminates the "royal range" (*Cordillera real*) in the north. South of it that alpine chain of unsurpassed beauty in outline and in abundance of formidable glaciers, but without the softening feature of meadows and forests—grand, solemn, and chilling—extends to its southern pillar, Illimani, the altitude of which was determined by Sir Martin Conway, on his *first* (and thus far *only*) ascent, in September, 1898, at 21,190 feet. Between Sorata and Illimani the strikingly individualized peaks exceed, as far as known, twenty thousand feet at only two or three places. The Karka-Jake (erroneously called Huayna Potosi) reaches 20,300, and the Chachacomani 20,600 feet.

Glaciers abound on the *Pacific slopes* of the chain. The Atlantic declivity is very steep; hence shows few of these truly alpine features. At present, and for a number of years past, the glaciers of the Bolivian Andes have been in slow retrocession. The deep clefts, meandering from the fronts of actual glaciers towards the upper Puna, or tableland, bear every mark of having been eroded by glacial action at a very remote period.

North of the Sorata group there is a break in the continuity of the snowy range. The Andes of Carabaya lie farther from the lake basin than those of Bolivia, but are visible from the western shores and from Puno. Their relative altitudes are as yet but imperfectly known. Their most important and most northerly group, Ananea and Palomani, may yet prove higher than believed, for both summits rise out of enormous glaciers and snow fields. South of them the chain is made up of picturesque clusters of sharp peaks and cones; but the snow-line is not unbroken, as farther south. The eastern slope is, as everywhere else in that region, very steep.

This extensive barrier, separating Lake Titicaca from the wooded lowlands of the Amazonian basin, acts to intensify the chill in the climate of Titicaca. The Indian, who looks at nature only from the standpoint of the dangerous or the useful—who feels, above all, his own helplessness in presence of incomprehensible phenomena—sees in the stately peaks the abodes of spirits, and worships them as such. The taller the mountain, the more powerful the Achachila (literally, "grandfather") supposed to dwell in it. To the Indians of the main islands in the lake the principal *Nevados* appeal mostly as originators of angry blasts and damaging frost.

The region of the lake, as well as the mountains, has as yet been but partially investigated from a geological point of view. The crest of the Bolivian Andes and the upper slopes are Silurian, but here and there traversed by upheavals of syenite, as, for instance, at the so-called Huayna Potosi. Lower down and as far as the middle of the table-land, or Puna, Devonian strata appear. On the west the Permian formation prevails. The basin proper is also crossed by streaks of carboniferous rocks, containing stone-coal of a fair quality, not seldom accompanied by trachytic (andesitic) dykes. The Puna south of the lake is said to be Devonian in the main. Explorations conducted by Prof. A. Dereims, the French geologist, will at last furnish us a true picture of the geology of the region.

The mineral resources of the surroundings of Lake Titicaca are not inconsiderable. Coal does not, as yet, play any rôle in production, which is the more regrettable that its quality is good and the seams are of easy access. Copper in its native state, as large chunks or blocks, but chiefly disseminated in minute particles through a Permian sand-rock, in proportions varying from less than ten to seventy-five per cent., crops out at Corocoro, near the Desaguadero, in enormous veins tilted at an angle of about forty-five degrees. Tin is worked in the cordillera not far south of La Paz; and it is also found at Carabuco, near the lake shore. Silver ores abound in the district of Sicasica, and gold is now washed on a large scale at the very doors of the City of La Paz. In the mineral wealth lies the future of the lake region and in the industries therefrom resulting; neither the vegetable nor the animal kingdom offers any inducements.

At an elevation of twelve thousand feet, vegetation, even under the tropics, is reduced to a minimum. Not many spots on the lake-shore are sheltered enough to permit the growth of trees and of low, bushy maize. The surroundings of the sanctuary of Copacavana offer a succession of favoured nooks, where, besides some trees imported by the Spaniards, like the eucalyptus, the wild olive tree (*Buddleya coriacea*), the keñua (*Polylepssis racemosa*), and *Sambucus Peruviana*, grow in stunted specimens. This is also the case on the southern promontory of Titicaca Island, at Keñuani, and especially in two gardens on the island erroneously ascribed to the Inca, while they are both Spanish and of the eighteenth century, if not later. On these two lovely spots an abundance of European flowers and some vegetables, also strawberries, still thrive under the shade of imported and indigenous trees. On the

peninsula of Huata similar spots are found; elsewhere vegetation is limited to the dismal Puna grass (*Stipa Ichu*) and smaller shrubs, some of which are used by the Indians in medicine and witchcraft.

Alimentary plants may be divided into two classes—indigenous and imported. Among the former the *potato* occupies the first rank. It is the leading staple of the mountain region in general. But cold and moisture prevent its preservation in the natural state. Combustible to dry the potato there is not enough; hence the only means to keep it is to let it freeze, then press out as fully as possible every trace of moisture, let it freeze again, and thus, reducing the tuber to a mere cork-like, insipid mass, render it invulnerable against cold and humidity. The chufia, as this unpalatable metamorphosis of the (otherwise splendid) potato is called, is the main food on these highlands, and of all classes of society, without exception. Next to the potato comes the oca (*Oxalis tuberosa*), the quinoa (*Chenopodium quinoa*), maize, and the so-called papa liza, a most indigestible tuber of the potato kind. Imported alimentary plants are limited to barley and to a coarse, large bean, the haba. Vegetables would grow very well on the islands. We have seen, on Koati, plants that were almost arboriferous; but the Indian is far too conservative to change his diet. He prefers his primitive food, heavy and yet not nutritious, to wholesome aliments unknown to his ancestors.

Neither hill nor vale is without flowers. Along the lake and in sunny coves the kantuka—carmine, red, yellow, and white—droops from the branches among the vivid green foliage of a tall shrub. On humid expanses the panti-panti displays its white or pink blossoms. Verbenas cover the slopes in patches. Many an insignificant bush has a modest but pleasing little flower, and the quinoa presents, when in bloom, entire fields draped in the national colours of Bolivia—red, yellow, and green. On the other hand, miles and miles offer nothing to the eye but, along the shores of the lake, lonely gray or dull green, with rocks intervening, or, in the interior, interminable levels of coarse Puna grass, dotted by the adobe or stone huts of the natives, their tiny fields, and an occasional drove of llamas.

Animal life is irregularly distributed. The middle of the lake sees occasionally a gull (*Larus serranus*) following the steamer. Of the six kinds of fishes thus far known few specimens appear on the surface. It is on the shores of bays like the large one of Achacache, on the waters of the picturesque harbours of the island of Titicaca and the peninsula of Huata, also on the roadsteads of

Chililaya and others, mostly where the tatora or lake reed (*Mallacochaete Tatora*) thrives in shallow places, that aquatic birds of the lake are mostly seen. The choka (*Fulica gigantea*), a stately water-hen of black metallic plumage, with bright-coloured head and bill, glides quietly over the little ruffled surface of inner bays. Turbulent divers (*Podiceps*, *Tachybaptus*, and *Centropelma*) furrow the water around them like diminutive tug-boats, crossing and chasing each other with amazing rapidity. Along the mainland the flamingo and the rose-coloured spoon-bill are not rare, and a dark-green ibis stalks over marshy expanses. An ashy gray night heron is sometimes seen erect on rocky points, and the black cormorant peoples smaller islands, affording the Indians, who visit them in frail balsas, a repulsive aliment in young birds and eggs with greenish yolks, both equally disgusting through their fishy smell and taste. A gray eagle soars over the rocks skirting the shores, and that handsome scavenger, the alkamari, stalks in pairs over fields and bare slopes. I forbear mentioning enigmatical beasts like the supposed seal, although there is enough in reports about the animal to excite legitimate curiosity. Neither do I dwell on the innocent toads, which the Indians gather and expose on dry rocks as often as they fear drouth. I also pass by the small scorpions, centipedes, and spiders, often disturbed by the opening of ancient sepulchres. But I cannot overlook the godfather of the Island of Titicaca, the species of wild-cat to which the name is due. *Titi* means the lynx-like feline haunting the shores of the Lake, from which, probably, it sometimes found ways and means of crossing over to the island. *Karka* (whence Kaka) signifies a rock, or cluster of rocks. The strangely-situated cliff on the island, which was a shrine since time immemorial, is called *Titi-Kala*, or *stone of the cat*, since there are on its vertical face some concavities recalling heads of cats, on which the Indians looked with superstitious awe. Hence the wild-cat (called *Mulu-Mulu* along the slopes of Illimani) has given its name to the main island, whence, after the sixteenth century, it became generally applied to the whole lake. To-day still, the Aymará call the water-sheet simply *kota*—lake or sea. The *Titi* pays disagreeable attention to domestic fowl. During the seventeenth century its occasional appearance on the island gave rise to the well-worn tale of the carbuncle, a cat with fiery eyes and a luminous stone on its forehead. In former times the vicuña and even the guanaco were occasional visitors of the lake-shore, and they roamed through the districts west and south of the lake. The eastern shore, as well as the

Andes, were and are, especially the latter, frequented by the vicuña only. What we were told about the occurrence of the guanaco is problematic. I would also allude here to the not uninteresting fact that the condor, that huge bird of prey and carrion, while roosting in the Bolivian Andes about Illimani, is hardly ever a visitor of the lake or the plateau, whereas the easily-domesticated Puna goose (*Benicla Melanoptera*) lives on one of the haciendas as tame as any ordinary member of the "civilized" species, and we had the daily visit of a pair of these handsome birds on the sandy shore of Challa, on the island.

Both the llama and the paca are kept in large numbers around the lake—the former as a beast of burthen, the latter for its precious wool. Along the base of the northern range, on the dismal and cold levels that skirt the snowy peaks of Suchez, of Katantika, Kololo and Altarani and Ca, the paca pastures by thousands. They do not, however, go up near the mountain passes, where, as all along the snowy range, emerald-green lagunes, fed from the glaciers, offer a far better drinking water than any on the Puna. The vizcacha accompanies the vicuña to the highest crests, but it also makes its home on the Puna, wherever clusters of rocks protrude. So does the chinchilla, on the Puna nearer the Chilian frontier.

Since the Spanish occupation the Indian has additional domestic animals. He has the ass, the mule, the horse, and cattle and sheep. But he takes no care of them; hence the breed is poor and weakly. The llama and its kind, however, he fondles, for it is a time-honoured associate.

Outside of the city of Puno and a few unimportant villages along the lake, the white population hardly exists. Indians—Quichua in the north and northeast, Aymará to the south, and Mestizos—are the overwhelming majority. Intercourse with them—protracted contact—is far from agreeable, especially with the Aymará, who are a retrograde, stubborn, and naturally blood-thirsty stock. Distribution of the settlements is unequal. After sallying from the lagoon of Chucuito, where the village of the same name and that of Acora are the chief places, we pass successively Juli, Ilave, Pomata, and Yunguyu, leaving Zepita in the distance. All these villages together, and their surroundings, have to-day, according to Peruvian statistics, as many Indians as at the time of the Conquest. The Peruvian coast is low and monotonous; it fronts the widest part of the lake called Pampa de Ilave, where storms are much feared. Already there, the largest island of the lake, Titicaca, appears, seemingly connected with the peninsula of Copacavana

facing it. As we approach, Titicaca detaches itself, assuming its true insular shape. It is about seven miles long, and has the form of an elongated toad. The lake makes not less than seventeen well-marked indentations into its shores, some of which are most picturesque bays. The backbone of the island is a long ridge, but the highest points lie outside of it—northwest and southeast. The former, Chullun-Cayani, overlooks the lake directly; the other, Pallasa, is off the shore, and both are 800 feet above the lake. The island is one of the most romantic spots imaginable, notwithstanding lack of vegetation. We lived on it for over five months in all, and, with all the inclemency of climate and the evil disposition of the eight hundred Indians who live on the two haciendas into which the island is divided—with all their constant disobedience of most positive orders from the owners to respect and attend us as if we had been the proprietors themselves—this marvellous island, with its coves, its promontories, its unparalleled panoramas and outlooks, its modestly picturesque ruins, remains, and will always remain, the ideal of our dreams.

It is as if a reflex of its beauty had been cast on the peninsula of Copacavana, from which it is separated by the narrow channel of Yampupata. The sanctuary of Our Lady of Copacavana, famous in Bolivia since 1586 (although the once beautiful church was only begun in about 1640,), stands on a lovely site; but, unfortunately, the village of Copacavana is a dreary hamlet, and only alive when the festivals of the Church gather thousands of boisterous Indians to dance in the plaza. Such dances are survivals to which the Indian clings with great tenacity, while their original meaning is only known to a small number of the aborigines. These celebrations, while attractive at first sight through quaintness and colour, become disgusting very soon through the carousals which form, and always formed, an indispensable corollary.

Copacavana has many natural charms. The triangle which the peninsula forms is as diversified in topography as odd in outline. Its Indian population is comparatively dense, of evil inclinations, and does not appear to have suffered any diminution since 1538. Tillage of the soil on a small scale and some cattle-raising give them occupation when their time is not taken up by feasting and carousing; and so it is all over Bolivia and the mountainous section of Peru.

Few lakes in the world have a greater number of islands and islets than Titicaca. Entrance to the bay of Chucuito is guarded by two large ones—Amantaní and Taquili, of which the latter has

served repeatedly as a place where political prisoners were left to pine. Beyond the main island of Titicaca, towards the Bolivian end of the lake, lies Koati—green, almost treeless, but notorious for its Inca ruins, not extensive nor architecturally remarkable, but well preserved and on a spot of unusual beauty, selected by the Indians for its warmth and because it faces the majestic summits of the Sorata chain, which are, to the Indian, very “big medicine.”

Around Titicaca Island are a number of small isles, that appear like remnants of a former connection between the peninsula of Copacavana and that of Huata. The straits of Tiquina, very narrow, but not deep, and with steep, rocky shores, separate the two promontories. They also separate the main lake from the southern, comparatively very shallow, basins of Chililaya or Huarina, and of Uinamarca, at the southwestern end of which opens the Desaguadero channel. Between the two basins lie a number of not unprepossessing islands, mostly inhabited. There are about thirty of them, many of which bear ruins of primitive settlements. South of the lake expands the bleak Puna, between twelve and fourteen thousand feet above the Pacific, and, at a distance of forty miles south of Chililaya, the cleft of the La Paz River opens, through which that stream, hugging the mountain notch of Illimani, meanders to the basin of the Amazon.

Of the pre-Columbian condition of the inhabitants of Titicaca basin, many ruins, promiscuously scattered, bear testimony. Aside from those of Tiahuanaco, the past of which is still shrouded in mystery, ruins of Inca origin in the shape of more or less elaborate storehouses of stone and adobe, and ceremonial edifices of modest size on the Island of Titicaca, on Koati, and around Copacavana—finally the many vestiges of Aymará occupation in the so-called Chullpas or dwellings with house-burial, on the Puna as well as in the mountains—show that, in pre-Spanish times, the lake region was occupied almost exclusively by Aymará Indians. These had, to a limited extent, been overcome by the Inca tribe of Cuzco, but never incorporated into a national or political union, of which no aggressive Indian tribe in America had any conception. These ruins indicate a population not in excess of the present number of Indians, but of a shifting disposition, to which Spanish rule put an end. The influence of the Incas was limited to levying tribute, and their architectural remains in the lake basin indicate permanence only in very few places.